CLAIMS:

1. An optical module, comprising:

at least one optical fiber having an end surface;

a gradient index rod lens, wherein the rod lens is placed at a position separated from the end surface of the at least one optical fiber by a space; and

an optical element that is separated from the rod lens,

wherein outgoing light from the at least one optical fiber is inputted to the optical element via the rod lens, and light reflected by the optical element is coupled to the at least one optical fiber via the rod lens, and

wherein, when a distance between the rod lens and the optical element is longer than a predetermined distance, and a lens length optimized for the distance is equal to or less than a predetermined pitch, the rod lens has end surfaces perpendicular to an optical axis.

2. An optical module according to claim 1, wherein the predetermined distance is about 0.4 mm.

3. The optical module according to claim 1, wherein the optimized lens length of the rod lens is in a range between 0.21 pitch and 0.1 pitch inclusive.

4. The optical module according to claim 1,

wherein the rod lens has a parabolic gradient index along a radial direction,

and wherein, when a calculation value L_0 of the distance L is computed according to the following formula based on a central axis refractive index n_0 of the rod lens, an index gradient constant $\sqrt{A}$, and the lens length Z,

$L_0 = 1/(n_0 \times \sqrt{A} \times \tan(\sqrt{A} \times Z))$, and

wherein the distance between the rod lens and the optical element is set shorter than the calculation value L_0

by a predetermined amount.

5. The optical module according to claim 4, wherein the predetermined value used for setting the distance between the rod lens and the optical element shorter than the calculation value L_0 is about 0.3 mm.

6. The optical module according to claim 1,

wherein the at least one optical fiber is a single incoming optical fiber that is located at an incoming side of the rod lens and is coaxial with the rod lens,

wherein an optical circulator is connected to the incoming optical fiber, the optical circulator having a first terminal, a second terminal, and a third terminal,

wherein light inputted to the first terminal is outputted from the second terminal to the incoming optical fiber, reflected by the optical element, and sent to the incoming optical fiber via the rod lens, and wherein light inputted to the second terminal is outputted only to the third terminal.

7. The optical module according to claim 1,

wherein the at least one optical fiber comprises an incoming fiber and an outgoing optical fiber, wherein the incoming optical fiber causes light to reach the rod lens from a part displaced from the optical axis, and wherein the outgoing optical fiber is located at a position to which light that is reflected by the optical element and passes through the rod lens is coupled.

8. The optical module according to claim 2,

wherein the at least one optical fiber comprises an incoming optical fiber that is located at an incoming side of the rod lens and another optical fiber located at a position to which light that is reflected by the optical element is coupled via the rod lens,

wherein the two optical fibers are held in parallel by a capillary, and wherein end surfaces of the optical fibers are arranged to be spaced from the end surface of the rod lens by an equal distance, and

wherein optical axes of the two optical fibers are substantially parallel to the optical axis of the rod lens.

9. An optical module using a gradient index rod lens, comprising:

first and second optical fibers, wherein the first and second optical fibers each have an end surface, and are arranged parallel to each other;

a gradient index rod lens, wherein the rod lens is placed at a position separated from the end surface of the optical fiber by a space; and

an optical element that is separated from the rod lens,

wherein outgoing light from the first optical fiber is inputted to the optical element via the rod lens, and light reflected by the optical element is coupled to the second optical fiber via the rod lens,

wherein the end surfaces of the optical fibers are inclined relative to a plane perpendicular to the optical axis of the rod lens by a predetermined angle, and

wherein, when a distance between the rod lens and the optical element is longer than a predetermined value, and a lens length optimized for the distance is equal to or less than a predetermined pitch, the rod lens has end surfaces perpendicular to an optical axis.

10. An optical module according to claim 9, wherein the predetermined value of the distance is about 0.4 mm.

11. The optical module according to claim 9, wherein the optimized lens length of the rod lens is in a range

between 0.21 pitch and 0.1 pitch inclusive.

12. The optical module according to claim 9,

wherein the rod lens has a parabolic gradient index along a radial direction,

and wherein, when a calculation value L_0 is computed according to the following formula based on a central axis refractive index n_0 of the rod lens, an index gradient constant $\sqrt{A}$, and the lens length Z,

$L_0 = 1/(n_0 \times \sqrt{A} \times \tan(\sqrt{A} \times Z))$, and

wherein the distance between the rod lens and the optical element is set shorter than the calculation value L_0 by a predetermined amount.

13. The optical module according to claim 9, wherein the first and second optical fibers are arranged to contact each other, and wherein contacting portions of the optical fibers are located on the optical axis of the rod lens.